Respiration

Respiration:

The oxidation of the absorbed food material in order to obtain energy is called respiration.

There are two types of Respiration in the organisms:

1. Anaerobic Respiration

2. Aerobic Respiration

Aerobic Respiration:

In most of the higher and larger organism, the glucose etc is oxidized by using molecular oxygen. This type of respiration is known as Aerobic Respiration. In aerobic respiration a mole of glucose is oxidized completely into carbon dioxide and water releasing enormous amount of energy. One glucose molecule in this respiration produces 686,000 calories of energy. Aerobic respiration thus produces 20 times more energy than the anaerobic respiration.

In aerobic respiration food is oxidized in presence of molecular oxygen.

Stages of Aerobic Respiration:

There are two stages of Aerobic Respiration:

(a) External Respiration

In this stage, the organisms take the air (containing oxygen) into their bodies. This is called external respiration. this stage includes the transport of oxygen obtained from the inhaled oxygen to each cell of the body.

(b) Internal Respiration

The second stage is called internal respiration. It consists of the oxidation of glucose, amino acid and fatty acids etc, with molecular oxygen. In this stage all these reactions are included which extract the chemical energy of glucose and other compounds and store it in the form of ATP molecule, this respiration is also called cellular respiration as it occurs within cells.

In the internal or cellular respiration glucose and other compounds are passed through such enzymatic reactions which release the chemical energy gradually in small amounts with the help of which ATP molecules are synthesized.

Anaerobic Respiration:

Some organisms oxidize their food without using any molecular oxygen. This is known as Anaerobic Respiration. In this type of respiration considerably less amount of energy is released as compared with the other type of respiration.

In anaerobic respiration a glucose molecule is broken down into two molecules of lactic acid with a release of only 47,000 calories of energy.

Glucose --------> 2 Lactic Acid + Energy (47,000 calories)

Importance of Anaerobic Respiration:

1. When earth came into being its environment was totally devoid of oxygen. The aerobic organisms cannot lie in anaerobic environment. The early organisms started respiration in the absence of oxygen to produce energy for survival of organisms.

2. Some existing organisms like bacteria and parasites which live in oxygen environment have anaerobic respiration.

3. Many useful bacteria and yeasts are anaerobic.

4. Even in the aerobic respiration of the first phase is anaerobic. The glycolysis which is the first phase of carbohydrate metabolism involves reaction which does not require the expenditure of molecular oxygen. This proves the idea that aerobic organisms have evolved from anaerobic organisms.

5. In our skeletal muscles, although aerobic metabolism takes place but in sustained activity when the oxygen supply cannot keep pace with energy demand, anaerobic respiration supplies the energy continuously by the breakdown of glucose to lactic acid.

ATP (Adenosine Triphosphate):

It is a chemical compound. ATP is an abbreviation of adenosine triphosphate. Its name indicates that it contains adenosine and three phosphate groups. Adenosine is formed of a nitrogenous base

called adenine and a sugar called ribose. In ATP three phosphate groups are attached to the adenosine in a series one after the other.

Significance of ATP

ATP is a big source of energy. The two terminal bonds between the phosphate groups contain large amount of the chemical energy. When these bonds are broken in enzymatic reaction, large amount of energy is released by which energy requiring activities are accomplished, like synthesis of various compounds of carbohydrates, fats, proteins and hormones etc or for carrying out any physical work like muscle contraction, heat production or transport of substances etc.

When the terminal bond is broken the ATP is changed into ADP and phosphate 7300 calories of energy are released.

Gaseous Exchange in Plants:

Plants get their energy from respiration. Plants have no special organ or system fro exchange of gases. The gaseous exchange in plants occurs in cells, of every part of the plant i.e. roots, stems and leaves etc according to their energy demand. The conducting system (xylem and phloem) of plants transports water and nutrients but plays no role in the transport of gases. The air spaces present between the cells of parenchyma of leaves, stem and roots are involved in the gaseous exchange.

Gaseous Exchange in Leaves and Young Stems

In the leaves and young stems, gaseous exchange occurs through stomata. Some gaseous exchange also occurs through cuticle.

Gaseous Exchange in Woody Stems and Roots

In woody stem and roots, there are present dead cells beneath the epidermis which form cork tissue. Later on, this tissue becomes porous. The pores are called lenticels. These are involved in gaseous exchange.

Gaseous Exchange in Leaves

The aquatic parts obtain oxygen for their respiration by diffusion from the dissolved oxygen in water. Whereas the land plants get their oxygen from air directly through their stomata which are more abundant on the lower surface than the upper surface of leaves.

Gaseous Exchange in Roots

The roots get their oxygen for gaseous exchange through diffusion from the air existing in the space between soil particles.

Process of Respiration in Plants:

The respiration in plants continues day and night. In this process, the oxygen from the airspaces in the leaves and stems is diffused into tissues and cells after getting dissolved in the film of water which is present over the cells. In the cells this oxygen oxidizes the carbohydrates and other organic compounds into carbon dioxide and water to produce energy. Some of the water (vapours) comes in the airspaces from where they diffuse out to the atmosphere through lenticels and stomata. The elimination of carbon dioxide is more evident from the parts without chlorophyll like growing seeds and buds. The water produced in this process becomes a part of the already present water in the body of plants. The various chemical reactions of respiration are controlled by the specific enzymes. This process occurs at a faster rate in the parts of the plant having rapid growth like growing seeds, buds, apical meristem of roots and shoots, because these parts require more energy to accomplish the growth process.

Relationship between Respiration and Photosynthesis:

The gaseous exchange in plant is not very evident during the day time as the products of respiration i.e. carbon dioxide and water are used in the process of photosynthesis. In the bright sunshine, because of high rate of photosynthesis the carbon dioxide produced in respiration falls short and therefore, some carbon dioxide has to be taken into the plant from outside for photosynthesis.

In the day time the plants therefore, take in carbon dioxide and expel out oxygen. The process of photosynthesis occurs in chloroplasts whereas the process of respiration takes place in cytoplasm and mitochondria.

Gaseous Exchange in Animals:

The gaseous exchange in different animals takes place by different methods and organs. In unicellular aquatic animals like amoeba, the dissolved oxygen in water diffuses directly through their cell surface into the interior of the animal and the carbon dioxide similarly diffuses out from their bodies into the external water. This is the simplest way of gaseous exchange and it can occur only in small animals with a diameter of less than one millimeter. These animals have greater surface area of volume ratio and have low rate of metabolism.

During evolution, as the animals became complex and complex and grew in their size, their skin or external body surface become impervious to water. Thus the gaseous exchange became

impossible through diffusion. In large animals certain organs were developed for exchange of gases w.g. the moist vascular skin, gills, lungs and tracheoles. These large animals have developed blood vascular system which transports oxygen from the respiratory surface to the deep cells and tissues in all parts of the body. The blood in all animals has some respiratory pigments like haemoglobin which carry large amount of oxygen efficiently from respiratory surface to the interior cells.

Properties of a Respiratory Surface:

1. Respiratory surface should have large surface area.

2. Respiratory surface should be moist.

3. Respiratory surface should be thin walled.

4. Respiratory surface should have blood supply.

Gaseous Exchange Through Skin:

For the exchange of gases through the skin the skin must be moist and richly supplied with blood. The oxygen is diffused from the external water to the blood and the carbon dioxide is diffused from the blood to exterior water. In amphibia and fishes the gaseous exchange occurs through the skin besides through the gills or lungs. The frogs and tortoises breath through the skin during their hibernation period.

Gaseous Exchange by Gills:

The gills are very effective for gaseous exchange in aquatic animals. Gills are of two types:

(a) External Gills

(b) Internal Gills

(a) External Gills

Some animals have external gills which project out of body of animals. These gills have very thin and highly vascularized surfaces e.g. the dermal papillae of star fish and arthropods.

(b) Internal Gills

These are present inside the body inner to skin e.g. in fishes and arthropods. Have you ever examined a fish closely? How ill you know that the fish is fresh or not? If the colour of gills is red then it is fresh but if the colour of gills is changed, it is definitely not fresh. The red colour of the fish gills shows the presence of oxygenated blood.

Gills of Fish:

In fishes the gills are present in the branchial cavity present on lateral sides of the body behind the head. This branchial cavity is covered over by an operculum. There is a counter current flow of water and blood in gills which ensures maximum exchange of oxygen and carbon dioxide between the blood and the bathing water. Water enters through the mouth, flows over the gills and goes out of the body from the opercular aperture.

Human Respiratory System:

In humans, there is very efficient respiratory system. It consists of certain organs which are called respiratory organs these include nose, pharynx, larynx, trachea, bronchi and bronchioles.

Nose

The air enters through the external nostrils into the nasal cavity. This is lined with mucous secreting epithelium and ciliated epithelium. The nostrils are lined with hairs. The nasal cavities, located above the oral cavity and behind the nose are covered with epithelial tissue.

The beating of cilia creates a current in the mucus that carries the trapped particles towards the back of the nasal cavity. From here the mucus drips into the throat and is swallowed. Mucus keeps the nasal cavities moist. Bones of the nose warm up the air. Mucus moistens the air. Hair filter the air and stop the dust particles bacteria and any other foreign substance from going to next part of respiratory system. In this way air is purified and is then pushed into the pharynx.

A number of cavities called sinuses open into the nasal cavity. The sinuses are lined with mucus secreting epithelium. The opening of sinuses into the nasal cavity is very narrow. If these openings are closed due to cold or inflammation, the sinuses get filled up with mucus this results in headache and changed voice.

Pharynx

The nasal cavity opens into the pharynx (throat) through two small apertures which are called internal nares or internal nostrils. The pharynx is muscular passage which extend from behind the nasal cavities to the opening of oesophagus and larynx. The air goes from the pharynx into the larynx.

Larynx

The upper most part of the wind pipe (trachea) is called the larynx. The larynx is a cartilaginous box. Two fibrous bands called vocal cords are located in this box. These vibrate to produce sound. Larynx is, also called sound box or voice box. The air enters the larynx through a small aperture called glottis which is guarded by a muscular flap called epiglotis which fits into this opening while the food is being swallowed into the oesophagus. It prevents the food from entering into the trachea and choking it. During breathing epiglottis keeps the glottis open so that air goes to trachea.

Trachea

The air tube (wind pipe) is known as trachea. It is about 12 cm long and lies in front of the oesophagus. It has incomplete C shaped cartilagenous rings which are regularly placed in its wall and all along its length. These rings prevent the collapsing of the tube nd thus keep the air passage wide open all the time. Trachea is also lined with ciliated mucous epithelium. Any foreign particles present in the inhaling air get trapped in the mucous that is moved out of the trachea by breathing of the cilia in the upward direction. In trachea air is further cleansed and filtered and then moved towards the lungs.

Bronchi

The trachea while passing the chest cavity divides into two smaller tubes which are called bronchi (single bronchus). Bronchi are similar in structure to the trachea but are smaller in diameter and they have in their walls small irregular catilageuous plates. Each bronchus enters into the lungs of its own side. The right bronchus divides into three secondary bronchi and the left bronchus divides into two secondary bronchi which serve the 3 right and 2 left lobes of the lungs respectively.

Bronchioles

the secondary bronchi further divide into very fine branches until they end in thousands of passage ways called respiratory bronchioles. The bronchioles have not cartilaginous plates in their walls. They have smooth muscle and elastic fibers.

Alveoli

The walls of the respiratory bronchioles have clusters of tiny branches(like bunches of grapes) that along with the respiratory bronchioles re the sites of gaseous exchange, these pouches or air sacs are called alveoli (singular: alveolus). The alveoli are enormous in number. Each lung has about three hundred million alveoli.

Pulmonary artery brings deoxygenated blood from the heart into the lung. Here, it divides and re-divides until it forms a network of fine capillaries over the wall of each alveolus. The walls of alveoli are very thin (1/1000 mm thick) and moist. Thus, alveoli are efficient site for gaseous exchange.

The Lungs

There is a pair of lungs present in the chest in man. Actually, the masses of alveoli constitute lungs and their lobes. The lungs re protected by the chest box from sides and by a doem shaped muscular diaphragm from below. Chest box or ribcage is made up of ribs. Between the ribs, there are present inter-costal muscles. The diaphragm is a muscular sheet which partitions the chest and abdomen.

The two lungs re covered by a double layered membrane called pleural membrane. There is a thin film of fluid in between the two layers. This watery fluid makes the movements of the lungs (expansion and contraction) easy. It also protects the lungs from external injuries.

Mechanism of Breathing:

Breathing occurs in two phases:

1. Inspiration

2. Expiration

Inspiration

1. During inspiration, the dome-shaped diaphragm contracts and becomes flat some what and thereby lowering the floor of the thoracic cavity.

2. The external inter-costal muscles contract raising the ribcage. A combined action of these two events expands the thoracic cavity, which in turn expands the lungs.

3. The air pressure within the lungs decreases.

4. Thus air from the environment outside the body is pulled into the lungs to equalize the pressure of both sides.

Expiration

1. The diaphragm relaxes and assumes dome like shape. During expiration, the external inter-costal muscles relax and the internal inter-costal muscles contract as a result of which ribcage drops.

2. The combined action of these two event decreases the volume of the thoracic cavity which in turn decreases volume of lungs.

3. The air pressure with in the lungs increases.

4. The air is thus forced out of the lungs.

Bad Effects of Smoking on Heath:

Smoking is injurious to human health. The smoke contains many chemical and gases. Dried tobacco leaves are used in cigarettes. The tobacco on burning produces a number of dangerous and toxic compounds.

Chemicals Present in Cigarette Smoke and Their Harmful Effects:

(a) Nicotine

1. Man is addicted to cigarette damages brain tissues.

2. Causes blood to clot more easily.

3. Harden walls of arteries.

(b) Tar

1. Kills cells in air passages and in lungs.

2. Increases production of mucous and phlegm in lungs.

3. Causes lung cancer.

(c) Carbon Monoxide

Prevents red blood cells from combining with and transporting oxygen around the body.

(d) Carcinogens

promote the growth of cancerous cells in the body.

(e) Irritants

1. Irritate air passages and air sacs in the lungs.

2. Kill cells at the surface of air passages.

3. Causes smoker's cough and lung cancer.

Combustion:

A chemical reaction in which a substance combines with oxygen and produce heat, light and flame is called Combustion.

Respiration:

A process that liberates chemical energy from organic molecules when oxidized is called Respiration. It occurs in all living cells. In fact respiration is a series of complex oxidation and reduction reactions in which energy is released bit by bit.

Photosynthesis:

The process in green plants by which green plants manufacture their own food by using carbon dioxide and water with the help of energy absorbed by chlorophyll from sunlight is called photosynthesis.

Relation of Combustion, Respiration and Photosynthesis:

Combustion is the process of burning in which wood, coal, methane, gas etc are burnt in the presence of oxygen, producing carbon dioxide and water accompanied with the release of energy. It is an exothermic chemical reaction.

Cellular respiration can be compared to burning of fuel in which organic food (carbohydrates, fats and proteins) rich in carbon burn in the presence of oxygen producing carbon dioxide, water and energy.

Respiration like combustion is a catabolic exothermic chemical process. However, the difference between the combustion and respiration is that the combustion takes place in one go, releasing the entire energy as the heat, which may be utilized or is lost into the environment. the respiration completes in several small steps. Each step is under the control of a specific enzyme, releasing energy in small amounts which can be stored in the form of ATPs. Photosynthesis, another metabolic process, is just opposite to combustion. Combustion is a catabolic process; the photosynthesis is an anabolic process. In photosynthesis organic substance is synthesized from carbon dioxide and water in the presence of sunlight energy and chlorophyll. The molecular oxygen is evolved as the by-product combustion is exothermic and releases energy, photosynthesis is endothermic and absorbed energy.

Photosynthesis and respiration are the two metabolic reactions opposite to each other. Photosynthesis takes place only in the gree parts of the plant body having chlorophyll, whereas respiration takes place in all the living cells of plants and animals. Mitochondria are the cellular organelles where respiration takes place while the organelles for photosynthesis re chloroplasts. Photosynthesis takes place during the day time only, whereas respiration takes place day and night. In photosynthesis body weight is increased but in respiration weight is decreased. Respiration is an oxidation reaction whereas photosynthesis is a reduction reaction and can be well understood by comparing their chemical reactions.

Chemical Equation in Respiration

Glucose + Oxygen -------> Carbon dioxide + Water + Energy (In presence of mitochondria and enzymes)

Chemical Equation In Photosynthesis

Carbon dioxide + Water --------> Glucose + Oxygen (In presence of chloroplast and solar energy)

Respiratory Organs of Insects:

The respiratory system of insects is called the Tracheal system. It is a network of interconnecting air filled tubes called trachea delivering air directly to the body tissue cells. Trachea open outside through pores called spiracles.

Each trachea has chitinous cuticle lining which prevents it from collapsing.

A pair of spiracles is usually located on the sides of each segment of the thorax and abdomen. Spiracles have valves to open or close them regulated by special muscles. This controls water loss from internal body tissue.

(Diagram)

Trachea break up into numerous smaller tubes called tracheoles which ramify among the body tissues ending blindly. Tracheoles lack a chitinous lining. At rest the tracheoles are filled with watery fluid through which gaseous exchange tkes place in dissolved state.

Ventilation is brought about by contraction and relaxation of abdominal muscles which result in a rhythmic pumping of air into and out of the trachea.

Gas exchange takes place in tracheoles which are permeable to gases and are filled with a fluid in contact with the body tissue. Since oxygen diffuses directly into the tissue cells, blood of insects does not have hemoglobin so it is white. However, removal of carbon dioxide is dependent on blood plasma which takes it up for removal via spiracles.